Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

Application of	)	
DIRECTV ENTERPRISES, LLC	)	Call Sign: S2132
For Minor Modification of Authorization to Launch and Operate a Ka-Band GSO FSS Satellite System at 101° W.L.	)	File No. SAT-MOD-2004_________

APPLICATION FOR MINOR MODIFICATION

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TABLE OF CONTENTS

Page

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APPLICATION FOR MINOR MODIFICATION

DIRECTV Enterprises, LLC ("DIRECTV") hereby requests that the Commission modify its authorization for a geostationary Ka-band satellite system at the 101° W.L. orbital location to allow DIRECTV to implement the minor changes set forth herein.[1] This request, which does not seek authority to use any additional orbital locations or additional spectrum beyond that for which DIRECTV is already authorized, is a minor modification to DIRECTV's existing license.

Among other things, the proposed modifications will (1) combine onto a single satellite the individual Ka-band payloads originally authorized for deployment on two satellites at 101° W.L.; (2) combine the Ka-band payload with a Direct Broadcast Satellite ("DBS") payload on a high-power hybrid satellite; and (3) relinquish spectrum no longer needed for inter-satellite links. As modified, the Ka-band satellite system will

[1] DIRECTV is simultaneously withdrawing a prior Application for Minor Modification of this authorization in favor of the instant application. *See* FCC File No. SAT-MOD-20011221-00136. It is also filing a separate but interrelated application for authority to launch and operate the DBS payload on DIRECTV 8 as a replacement for another satellite currently operating at 101° W.L.

provide DIRECTV additional capacity for backhauling the signals of local broadcast stations as it continues to roll out local-into-local services in additional markets.

Consistent with Commission rules,[2] DIRECTV intends to implement these changes, at its own risk, pending Commission action on this request in order to complete construction and launch of its modified satellites within the next year. Given the short timeframe in which it must accomplish these objectives in order to meet its launch milestone, DIRECTV requests that the Commission grant this application as expeditiously as possible.

I. BACKGROUND

In May 1997, as part of the first Ka-band satellite processing round, the Commission authorized DIRECTV's predecessor in interest, Hughes Communications Galaxy, Inc. ("Hughes"), to launch and operate a GSO satellite system to provide Fixed-Satellite Service.[3] Hughes proposed to use its system "to offer services such as direct-to-home services and high speed personal computer access to the Internet and on-line services, telephony, narrow-band data, high-speed data, videoconferencing, [and] high capacity two-way communications."[4] Among other things, Hughes received authority to operate two Ka-band spacecraft at the 101° W.L. orbital location.

In January 2001, the Commission established milestone requirements for Hughes' Ka-band satellite authorizations. Specifically, it required Hughes to commence construction of its first satellite by January 2002 and, with respect to the 101° W.L.

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[2] 47 C.F.R. § 25.113 (f).

[3] *See Hughes Communications Galaxy, Inc.*, 13 FCC Rcd. 1351 (Int'l Bur. 1997), *modified*, 16 FCC Rcd. 2470 (Int'l Bur. 2001), *further modified*, 16 FCC Rcd. 12627 (Int'l Bur. 2001). Hughes was initially authorized to operate in the 28.35-28.6/29.25-30.0 GHz bands for uplinks and in the 19.7-20.2 GHz band for downlinks.

[4] *Id.* at 1352.

orbital location, to launch and operate a satellite by June 25, 2005.[5] In June 2002, the Commission found that the first milestone requirement under this license had been satisfied.[6] Through two *pro forma* authorizations, the license was eventually assigned from Hughes to DIRECTV.[7]

DIRECTV has one hybrid Ka-band/BSS spacecraft currently under construction by Space Systems/Loral ("Loral"), which DIRECTV has named DIRECTV 8 and designated for use at 101° W.L.[8] By this application, DIRECTV seeks to modify its Ka-band authorization at 101° W.L. to conform it to the design and parameters of the DIRECTV 8 spacecraft currently under construction at Loral.

The proposed modifications are designed to optimize the satellite's capabilities in light of advances in technology and recent changes in the marketplace for broadband and other satellite services. These changes allow DIRECTV to incorporate state-of-the-art engineering to achieve enhanced flexibility of service offerings. Among the changes involved in this modification are: (1) improved TT&C operating in Ku-band (as opposed to C-band transfer orbit and Ka-band on station); (2) simplification of satellite payload by foregoing complicated and costly on-board processing; and (3) the combining of the two

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5 *Hughes Communications Galaxy, Inc.*, 16 FCC Rcd. 2470 (Int'l Bur. 2001). In this same order, the Commission authorized Hughes to operate downlinks in the 18.3-18.8 GHz band and inter-satellite links in several bands.

6 *See* Public Notice, 17 FCC Rcd. 11272 (Int'l Bur. 2002).

7 In April 2002, the Commission authorized the *pro forma* assignment of this license from Hughes to Hughes Network Systems, Inc. ("HNS"). *See* FCC File No. SAT-ASG-20011204-00110. In May 2004, the Commission authorized the *pro forma* assignment of this license from HNS to DIRECTV. *See* FCC File No. SAT-ASG-20040520-00101.

8 DIRECTV's corporate parent, The DIRECTV Group, Inc., also has three Ka-band satellites under construction by Boeing Satellite Systems, two of which have been designated for launch to the 99° W.L. and 103° W.L. orbital locations, that are scheduled to be launched by June 2005. Those two Boeing spacecraft are the subjects of separate modification applications. *See* FCC File Nos. SAT-MOD-20040614-00113 and –00114. The third Boeing spacecraft is a ground spare.

Ka-band satellite payloads currently authorized at this orbital location onto a single satellite.

The modifications proposed in this application will provide DIRECTV with a new capability for backhauling local broadcast signals from regional collection points to its broadcast center using its own facilities, with the resulting efficiencies and cost savings enabling DIRECTV to provide local-into-local services in more markets. The system, with proposed modifications, is fully compliant with Commission rules relating to Ka-band blanket earth station licensing.

II. GRANT OF THIS APPLICATION WOULD SERVE THE PUBLIC INTEREST

DIRECTV and its affiliates have invested years of effort and over $1.5 billion in developing and implementing a Ka-band satellite system.[9] Most recently, following News Corporation's investment in DIRECTV, the company made a strategic decision that its Ka-band authorization at 101° W.L. could best be used to support DIRECTV's provision of local-into-local services throughout the United States. DIRECTV also identified the need for additional back-up capacity for its DBS fleet to replace a satellite that is nearing the end of its useful life. Fortunately, DIRECTV found that, due to a third party's decision not to take delivery, Space Systems/Loral ("Loral") had nearly completed construction on a satellite that would, with a few modifications, be able to support a hybrid DBS/Ka-band payload. This ready-made platform provided DIRECTV with an opportunity to address its DBS objectives while also meeting the fast-approaching launch and operation milestones under its Ka-band authorization. In fact, DIRECTV's contract with Loral calls for completion of the satellite on an expedited schedule that will achieve delivery of the DIRECTV 8 satellite in time for launch in the

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[9] *See* Letter from Michael L. Cook to Thomas S. Tycz, FCC File No. SAT-LOA-19931203-00040 (dated Feb. 20, 2004).

first half of 2005. DIRECTV has also made arrangements with International Launch Services for a launch on the Proton vehicle in that timeframe. Thus, DIRECTV has put into place all of the financial, contractual, and organizational resources necessary to achieve the launch and operation of the DIRECTV 8 satellite prior to the expiration of its June 25, 2005 operational milestone. Combined with the launch of DIRECTV's other Ka-band satellites, this will mark the true inauguration of the band for commercial services.

The modifications proposed in this application will help to ensure that DIRECTV 8 will operate efficiently and effectively and will be able to provide services that will enhance DIRECTV's overall consumer offerings. For example, the introduction of a larger and more powerful spacecraft has enabled DIRECTV to combine two Ka-band payloads (each covering half of the 1000 MHz of uplink and downlink spectrum available) and a Ku-band DBS payload onto a single satellite, offering additional capabilities for backhaul and other services that will enhance DIRECTV's operations. The addition of this satellite will mark a new stage in the evolution of DIRECTV's network architecture, providing new FSS capabilities where none previously existed and thereby enhancing DIRECTV's ability to respond to the rapidly changing needs of its customers in the satellite services markets.

While this minor modification will provide valuable benefits, it will create no offsetting public interest concerns. It will not increase harmful interference into adjacent satellite systems, even though the slight offset from its nominal orbital location (to 100.85° W.L.) will place it somewhat closer to another Ka-band satellite operated by a DIRECTV affiliate. It does not seek authority to use any additional orbital locations or additional spectrum beyond that for which DIRECTV is already authorized. Indeed, as part of the proposed modification, DIRECTV will relinquish spectrum that it is currently authorized to use for inter-satellite links and will combine the payloads on its two authorized satellites at the 101° W.L. location onto a single space station. Accordingly, this proposal is fully consistent with long-established Commission precedent that allows licensees to modify the design of their licensed systems during the construction phase to take into account changes in technology and to otherwise optimize their systems.[10] Consistent with Commission rules[11] and in order to meet its launch milestone, DIRECTV intends to implement these changes, at its own risk, pending Commission action on this request.

In addition, DIRECTV 8 will be a hybrid satellite, combining DBS and Ka-band payloads on a single space station. This makes obvious sense: DIRECTV currently has separate licenses for satellites operating in two different bands at the same orbital location, and using that slot with one hybrid satellite equipped with both payloads is plainly more efficient than building two satellites. This is particularly important at the highly congested 101° W.L. orbital location, where six satellites currently operate.[12] The Commission has historically favored the use of hybrid satellites due to their patent efficiency advantages.

> Operating a state-of-the-art hybrid satellite at a particular orbital location may be more efficient than operating two single-band satellites at that location. Construction, launch and insurance costs for one, albeit larger,

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10 *See, e.g., EchoStar Satellite Corp.*, 18 FCC Rcd. 15862 (Int'l Bur. 2003) (minor modification of Ka-band satellite license to conform to actual construction); *R/L DBS Company, LLC*, 18 FCC Rcd. 7694 (Int'l Bur. 2003) (minor modification allowed to incorporate latest technology so long as no significant increase in interference); *Teledesic LLC*, 14 FCC Rcd. 2261, 2263-64 (Int'l Bur. 1999)(finding a minor modification where changes will not significantly increase interference to other systems).

11 47 C.F.R. § 25.113 (f).

12 In addition to DIRECTV 1, 1R, 2, and 4S, the AMC-4 and AMSC-1 satellites operate at the nominal 101° W.L. orbital location.

> satellite will be lower than for two satellites. Moreover, advances over the past several years have made it possible to construct hybrid satellites that have technical capabilities equivalent to single-band satellites. Thus, hybrid satellites can provide cost savings to operators and customers with no decrease in technical performance.[13]

The hybrid DIRECTV 8 satellite will enable DIRECTV to capture these efficiencies and significantly reduce the costs of operating in both authorized bands. Moreover, the Commission specifically stated that it would permit Ka-band licensees to build hybrid satellites where they are authorized to operate in other bands at the same orbital location, provided all other technical and service requirements for the particular band are met (as they will be here).[14]

For the foregoing reasons, DIRECTV requests that the Commission grant this application as expeditiously as possible.

III. Information Required by Section 25.114(c) of the Commission's Rules

1. Name, Address and Telephone Number of Applicant

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2. Name, Address and Telephone Number of Contacts

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13 *Hughes Communications Galaxy, Inc.*, 5 FCC Rcd. 3423 (1990). *See also EchoStar Satellite Corp.*, 18 FCC Rcd. 15875, 15878 (Int'l Bur. 2003) ("the Commission has recognized the cost efficiencies inherent in hybrid satellites and has attempted to accommodate hybrid satellites where possible"); *Hughes Communications Galaxy, Inc.*, 7 FCC Rcd. 7119, 7120 (Com. Car. Bur. 1992) (recognizing cost and other efficiencies).

14 *See Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, 12 FCC Rcd. 22310, 22322 (1997).

3. Type of Authorization Requested

DIRECTV seeks to modify its existing license to launch and operate a non-common carrier Ka-band satellite at the 101° W.L. orbital location, using the 18.3-18.8 GHz and 19.7-20.2 GHz downlink bands and the 28.35-28.6 GHz and 29.25-30.0 GHz uplink bands. Among other things, DIRECTV seeks authorization for a hybrid satellite, to be named DIRECTV 8, that will provide Fixed-Satellite Service ("FSS") in the Ka-band and Direct Broadcast Satellite ("DBS") service in the Ku-band. This application relates solely to the Ka-band portion of the proposed hybrid satellite.[15] DIRECTV also hereby relinquishes that portion of its Ka-band license authorizing the use of spectrum for inter-satellite links at this orbital location.

4. General Description of Overall System and Facilities, Operations and Services

DIRECTV 8 will consist of a geostationary satellite located at 101° W.L. (nominal) and associated ground station equipment. DIRECTV 8 is a hybrid high-power satellite designed to provide Ka-band FSS and Ku-band DBS services in the United States. The on-station telemetry, tracking, and control ("TT&C") functions will be provided in the 12.2-12.7 GHz (space-to-Earth) and 17.3-17.8 GHz (Earth-to-space) DBS frequency bands.

The DIRECTV 8 Ka-band payload provides four wideband (*i.e.*, 250 MHz) transponder channels and four uplink spot beams. These receive spot beams are pointed toward four regional uplink collection points: Northwest (Seattle, WA); Central (Castle Rock, CO); Southeast (Atlanta, GA); and Northeast (New York, NY). Two of the uplink beams (*i.e.*, Northwest and Southeast) are designed for receiving RHCP, and the other

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15 Information related to the DBS portion of the proposed hybrid satellite is being filed concurrently in an application to modify DIRECTV's DBS authorization at 101° W.L.

two (*i.e.*, Central and Northeast) for receiving LHCP. All uplinks can be routed to either of two downlink spot beams directed toward Los Angeles, CA or Kansas City, MO, and transmitted with RHCP or LHCP. The primary configuration for the Ka-band payload routes all four uplinks to one primary 85W TWTA for transmission by either of the two downlinks. A secondary configuration routes pairs of transponder channels to each of two 85W TWTAs, for transmission by both downlinks. The 85W TWTAs are operated at approximately 7 dB OBO, which results in approximately 17 watts of power output.

5. Operational Characteristics

5.1 Frequency and Polarization Plan

The frequency band-to-uplink beam allocation is given in Table 5-1. From this table it can be seen that each uplink beam can support up to two wideband channels (*i.e.*, a full 500 MHz of contiguous spectrum) in a given polarization. The DIRECTV 8 channelization plan and the Ka-band frequency plan are summarized in Tables 5-2 and 5-3, respectively. It is expected that each 250 MHz transponder will be utilized primarily to carry multiple channels of local broadcast programming material from remotely located aggregation points back to DIRECTV's Los Angeles broadcast center. The satellite will also provide a redundant link for communications from the broadcast center in Castle Rock to the one in Los Angeles.

Table 5-1. Frequency Band-to-Uplink Beam Combinations

Uplink Operation Restrictions						
Uplink	Freq Band (GHz)	Uplink Polarization	Permitted* Polarization Combinations			
Upper Frequency Group			U1	U2	U3	U4
Castle Rock	29.5-29.75	LHCP	X	X		
	29.75-30.0	LHCP	X		X	
Seattle	29.5-29.75	RHCP			X	X
	29.75-30.0	RHCP		X		X
*Upper Group Independent of Lower Group						
Lower Frequency Group			L1	L2	L3	L4
New York	28.35-28.6	LHCP	X	X		
	29.25-29.5	LHCP	X		X	
Atlanta	28.35-28.6	RHCP			X	X
	29.25-29.5	RHCP		X		X

Table 5-2. Ka-Band Uplink Channelization Plan

Channel Designation	Pol	Channel Center Frequency (MHz)	Channel Bandwidth (MHz)
---		---	---
A1	LHCP	29,625.00	250.00
A2	LHCP	29,875.00	250.00
B1	RHCP	29,625.00	250.00
B2	RHCP	29,875.00	250.00
---		---	---
C1	RHCP	28,475.00	250.00
C2	RHCP	29,375.00	250.00
D1	LHCP	28,475.00	250.00
D2	LHCP	29,375.00	250.00
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Table 5-3. DIRECTV 8 Ka-Band Frequency and Polarization Plan

Band Designator	Band C1/D1	Band C2/D2	Band A1/B1	Band A2/B2
Uplink Frequency Range (GHz)	28.35-28.6	29.25-29.5	29.5-29.75	29.75-30.0
Uplink Polarization	LHCP/RHCP	LHCP/RHCP	LHCP/RHCP	LHCP/RHCP
Transponder Bandwidth	250 MHz	250 MHz	250 MHz	250 MHz
Transponder Center Frequency	28.475 GHz	29.375 GHz	29.625 GHz	29.875 GHz
Downlink Frequency Range (GHz)	18.3-18.55	18.55-18.8	19.7-19.95	19.95-20.2
Downlink Polarization	RHCP/LHCP	RHCP/LHCP	RHCP/LHCP	RHCP/LHCP
Transponder Bandwidth	250 MHz	250 MHz	250 MHz	250 MHz
Transponder Center Frequency	18.425 GHz	18.675 GHz	19.825 GHz	20.075 GHz

The wideband channels can support virtually any mix of carrier types within the passband of the channel. A representative channelization plan, for example, could take each of the 250 MHz transponders and further sub-divide them into six 36 MHz channels. In this case, each 36 MHz channel would be operated with a 40 MHz offset from the center frequency of adjacent channels with a small guard band (*i.e.*, 5 MHz) on each end of the wideband channel.

5.2 Communications Payload

5.2.1 Uplink Transmissions

Table 5-4 reflects the G/T performance summary for each of the four uplink beams. Note that the maximum G/T is specified at beam peak and that the G/T decreases, dB-for-dB, as one moves away from beam peak. The edge of coverage contour is also defined in this Table.

Table 5-4. Worst Case Ka-Band G/T Performance Summary

	Seattle			Castle Rock			Atlanta			New York		
	Peak (dB)	EOC (dB)	Delta (dB)	Peak (dB)	EOC (dB)	Delta (dB)	Peak (dB)	EOC (dB)	Delta (dB)	Peak (dB)	EOC (dB)	Delta (dB)
Uplink G/T (dB/K)	8.9	6.2	2.7	11.7	7.3	4.4	9.3	6.1	3.2	7.8	6.1	1.7

In the primary configuration, channels from all four uplink beams are combined and then routed through one power amplifier (*i.e.*, an 85W TWTA) to either downlink, and only one downlink is active for this configuration. An alternate to the primary configuration routes channels from the Atlanta and New York uplinks through one 85W TWTA, and channels from the Seattle and Castle Rock uplinks through the other 85W TWTA. In this alternate configuration, both downlinks are active, and the specific pairs of uplinks routed to the Kansas City and Los Angeles downlinks are set by configuration of an output beam select switch. A third configuration routes the channels from the Seattle and Castle Rock uplinks to transmit to either Kansas City or Los Angeles or both. The New York and Atlanta uplinks are inactive for this configuration. The emission designators to be used on the DIRECTV 8 Ka-band uplinks are 24M0G7W, 36M0G7W and 54M0G7W, with associated allocated bandwidths of 24 MHz, 36 MHz, and 54 MHz, respectively.

The uplink frequency/channelization plan is shown in Table 5-2. Diplexers and hybrids in front of the receivers combine uplinks from various sites and route them to receivers via select switches. Three different LO frequencies are available and are used in various combinations. Table 5-1 shows the various uplink combinations**.**

The performance of the input diplexer has been predicted by simulation, correlated with test data taken on a nearly identical unit from previous programs. Figures 5-1 and 5-2 show the predicted rejection and insertion loss for a typical channel, normalized to an input channel center frequency, over the protoflight temperature range. The multiple responses show the potential effect of temperature shifts and misalignment. The uppermost channel of the 29.5-30.0 GHz receive band (*i.e.*, A2 or B2) is shown. The other wideband channels will exhibit similar characteristics.

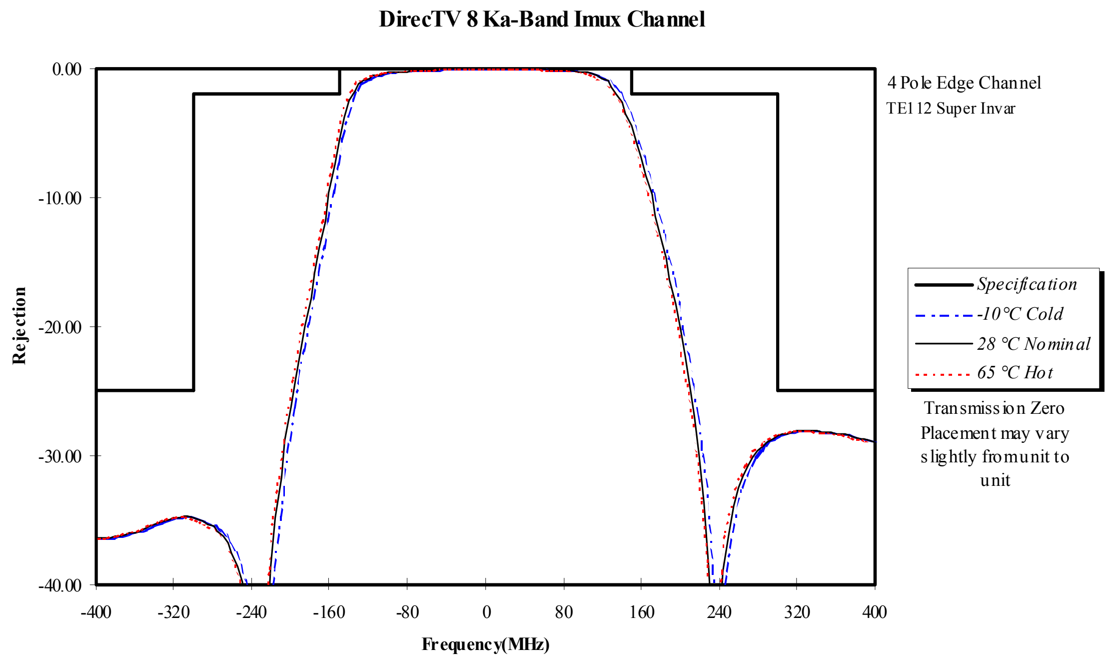

Figure 5-1. Typical Ka-Band Input Diplexer Wideband Channel Predicted Rejection

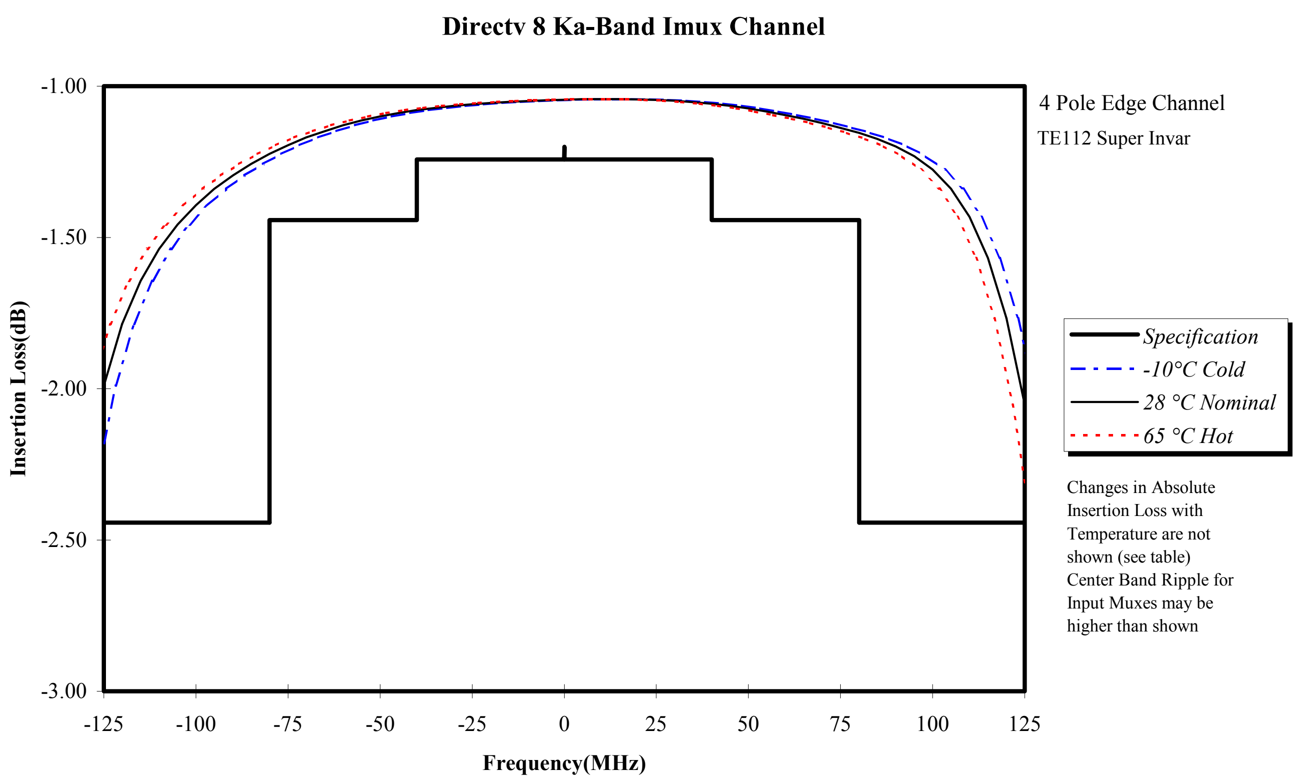

Figure 5-2. Typical Ka-Band Input Diplexer Wideband Channel Predicted Insertion Loss

The Ka-band channel filter limits the Ka-band spectrum after down-conversion by the receiver. The frequency plan for the channel filters is shown in Table 5-4.

Table 5-4. Ka-Band Channel Filter Frequency Plan

Channel Designation	Channel Center Frequency (MHz)	Channel Bandwidth (MHz)
---	---	---
a1	19,825.00	250.00
a2	20,075.00	250.00
b1	18,425.00	250.00
b2	18,675.00	250.00
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The performance of the channel filters has been predicted by simulation, correlated with test data from previous programs. Figures 5-3 and 5-4 show the predicted rejection and insertion loss over the protoflight temperature range for the 19.7-20.2 GHz frequency range, normalized to the channel center frequency. Figures 5-5 and 5-6 show the predicted rejection and insertion loss over the protoflight temperature range for the 18.3-18.8 GHz frequency range, normalized to the channel center frequency. The multiple responses show the potential effect of temperature shifts and misalignment.

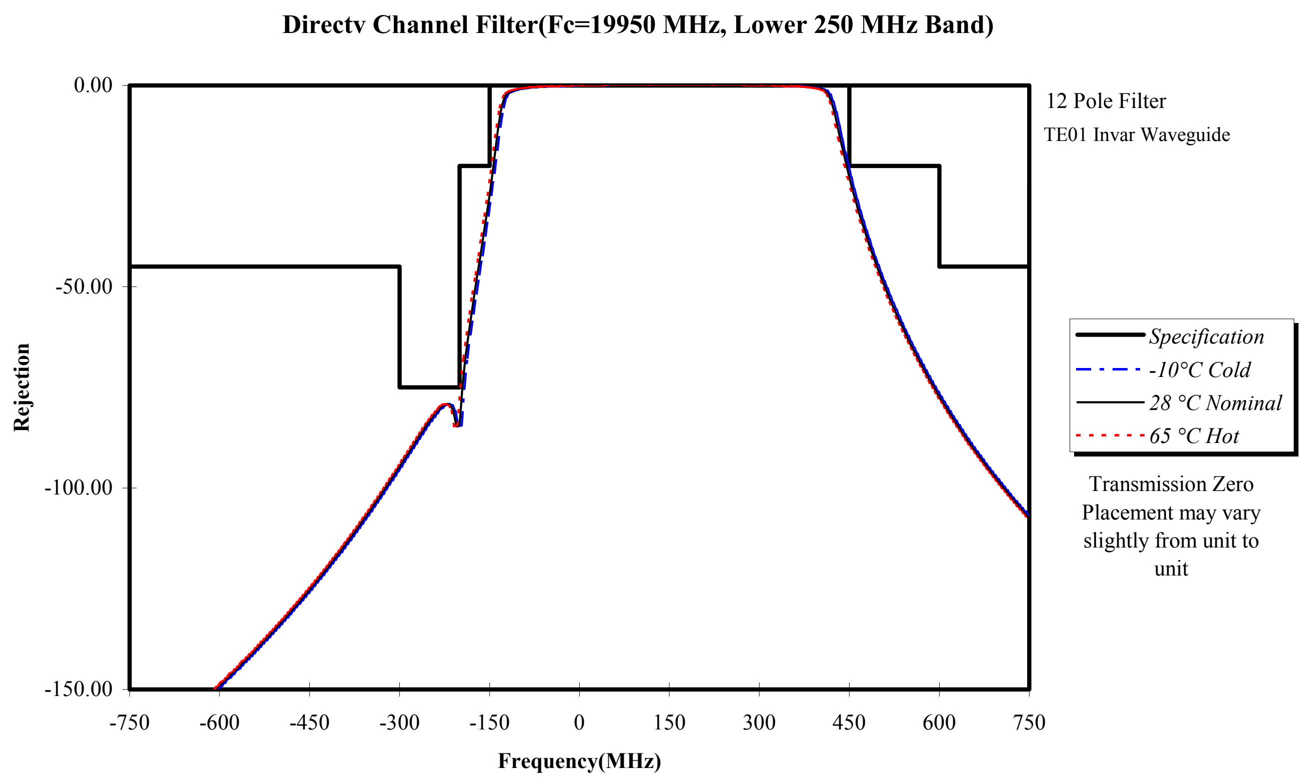

Figure 5-3. Ka-Band 19.7-20.2 GHz Channel Filter Predicted Rejection

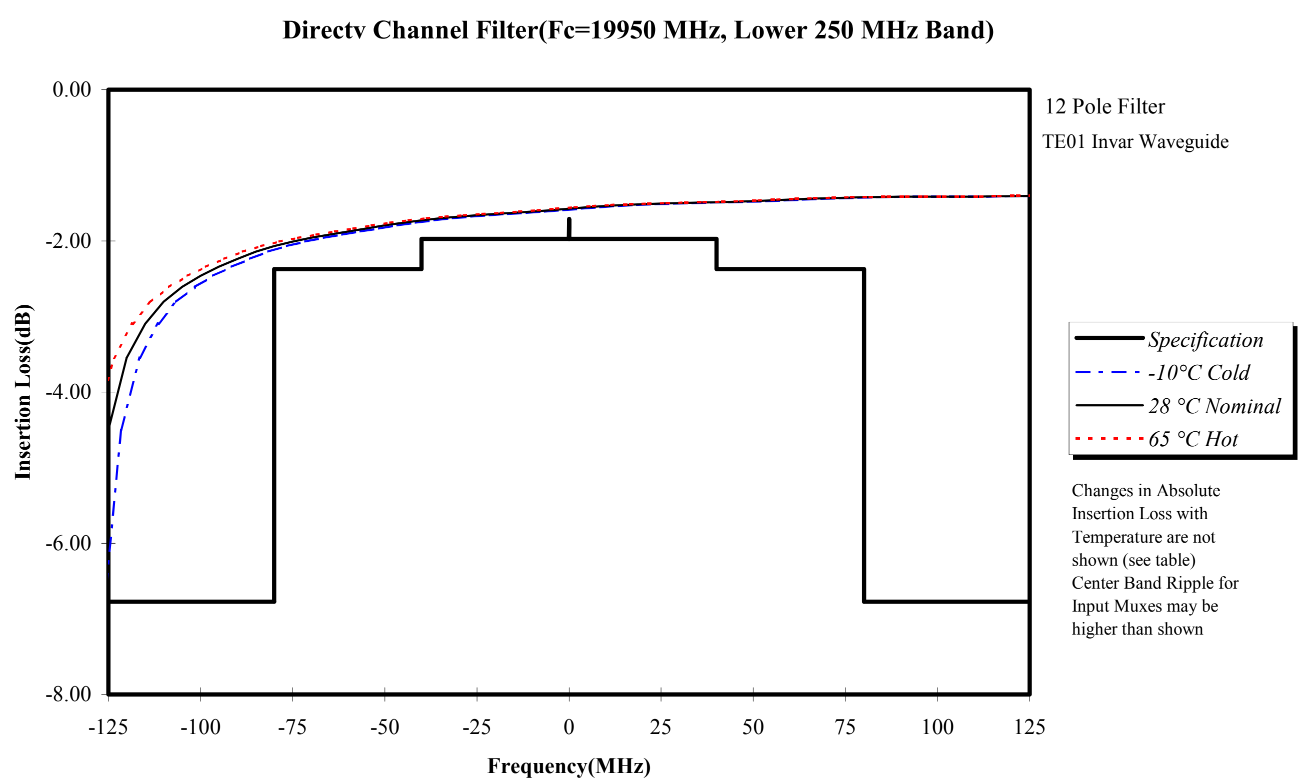

Figure 5-4. 19.7-20.2 GHz Lower 250 MHz Channel Filter Predicted Insertion Loss

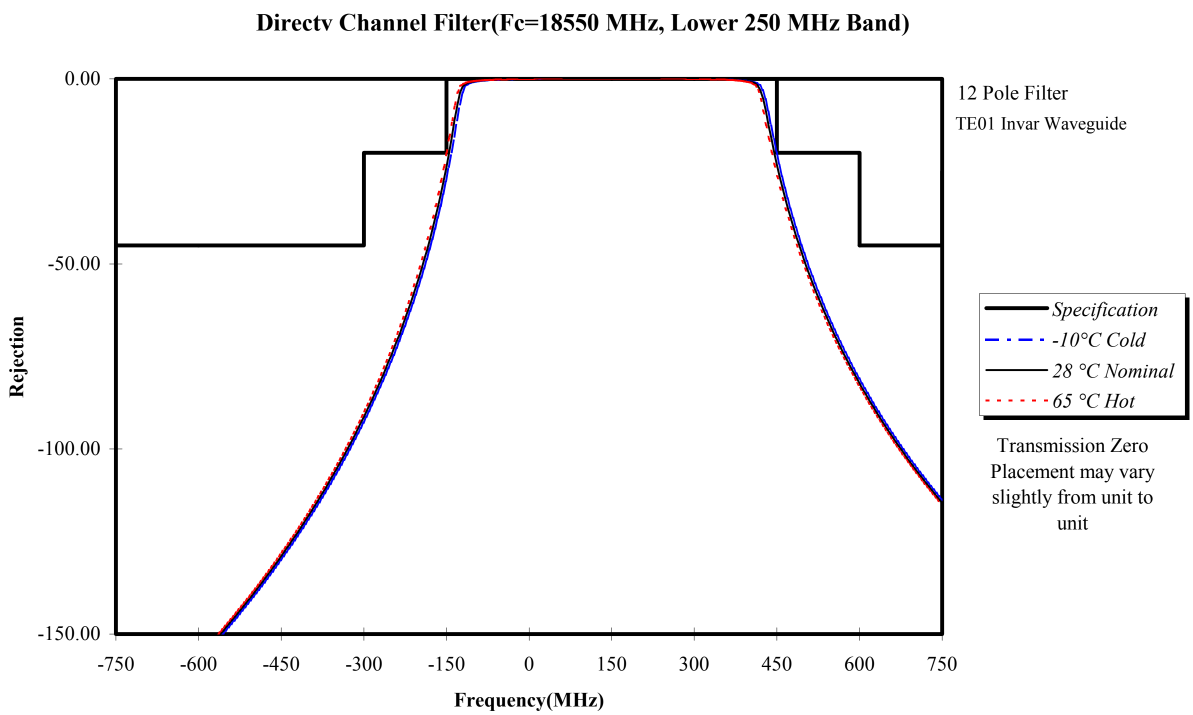

Figure 5-5. Ka-Band 18.3-18.8 GHz Channel Filter Predicted Rejection

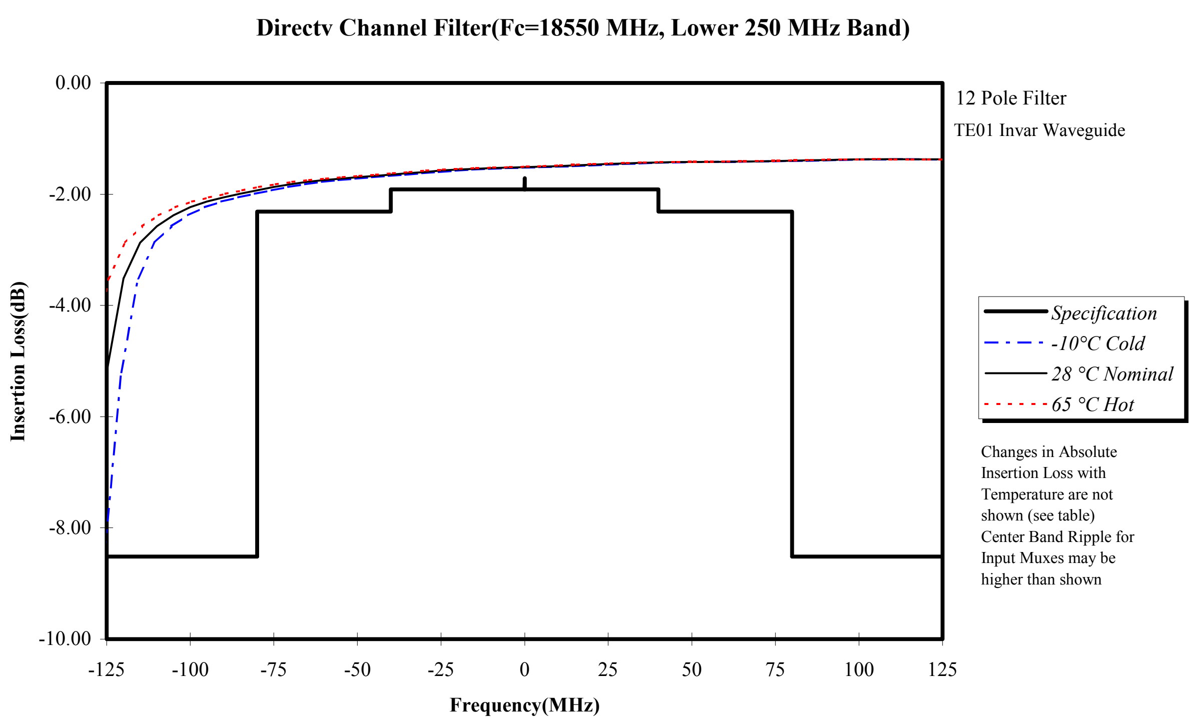

Figure 5-6. 18.3-18.8 GHz Lower 250 MHz Channel Filter Predicted Insertion Loss

Note that Figures 5-3 and 5-5 show the predicted rejection for the entire output frequency range 19.7-20.2 GHz and 18.3-18.8 GHz, respectively, while Figure 5-4 and 5-6 illustrate the predicted insertion loss for the lowermost channel (a1 or b1) in each of these bands. The upper channel (*i.e.*, a2 and b2) insertion loss response will be a mirror image of the lower side channel performance shown in Figures 5-4 and 5-6, respectively.

5.2.2 Downlink transmissions

The Ka-band payload has a maximum EIRP of 41.8 dBW per carrier. The link budgets contained in Appendix A clearly indicate that the satellite can readily support multi-carrier operation under various operating configurations. The payload has a commandable output level channel amplifier (automatic level control, or ALC), with an input dynamic range of 21 dB and a commandable output level range of 15.5 dB. In addition to this ALC mode of operation, the satellite is also capable of operating in fixed gain mode with a commandable gain range of 31 dB, in 1 dB steps. The emission designators to be used on the DIRECTV 8 Ka-band downlinks are 24M0G7W, 36M0G7W and 54M0G7W, with associated allocated bandwidths of 24 MHz, 36 MHz, and 54 MHz, respectively.

The Ka-band output filter limits the amplified Ka-band spectrum for transmission to the antenna. The frequency plan for the output filter is shown in Table 5-7.

Table 5-7. Ka-Band Output Filter Frequency Plan

Mux	Band/Channel Designation	Center Frequency (MHz)	Operational Bandwidth (MHz)
Dual Band Output Filter Assembly	Band a (includes a1 and a2)	19950	500
	Band b (includes b1 and b2)	18550	500
	Channel a1	19825	250
	Channel a2	10075	250
	Channel b1	18425	250
	Channel b2	18675	250

Due to the separated transmit frequency bands, the desire to have a single amplifier, and the need to reject frequencies between the transmit bands, the output filter needs to have a two-passband response. As a result, the output filter consists of two waveguide filters for each band, connected to a pair of manifolds, so that there is one input and one output. The output filter assembly is followed by a corrugated waveguide low pass filter to eliminate receive, 2^{nd}, and 3^{rd} harmonic responses.

The performance of the output filter has been predicted by simulation, correlated with test data from previous programs. Figures 5-7 and 5-8 show the predicted rejection and insertion loss for the output filter over the protoflight temperature range. Figure 5-7 shows the filter rejection across the entire 500 MHz band of 18.3-18.8 GHz. The multiple responses show the potential effect of temperature shifts and misalignment. Figure 5-8 shows the insertion loss for the lowermost channel (*i.e.*, 18.3-18.55 GHz). The upper channel (18.55-18.8 GHz) will be a mirror image of the lower channel performance. The output filter for the 19.7-20.2 GHz band will be nearly identical in response to the 18.3-18.8 GHz band filter shown in these figures, with the filter center frequency appropriately adjusted. Figure 5-9 shows the combined response of the two-filter/manifold combination in comparison with the rejection specification.

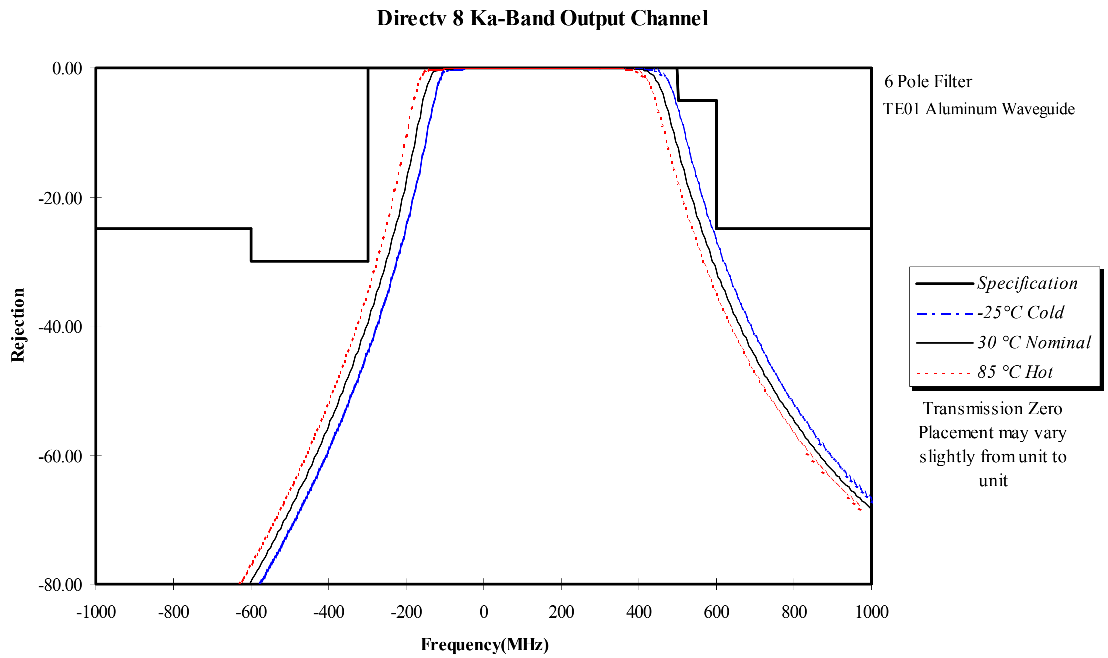

Figure 5-7. 18.3-18.8 GHz Ka-Band Output Filter Predicted Rejection

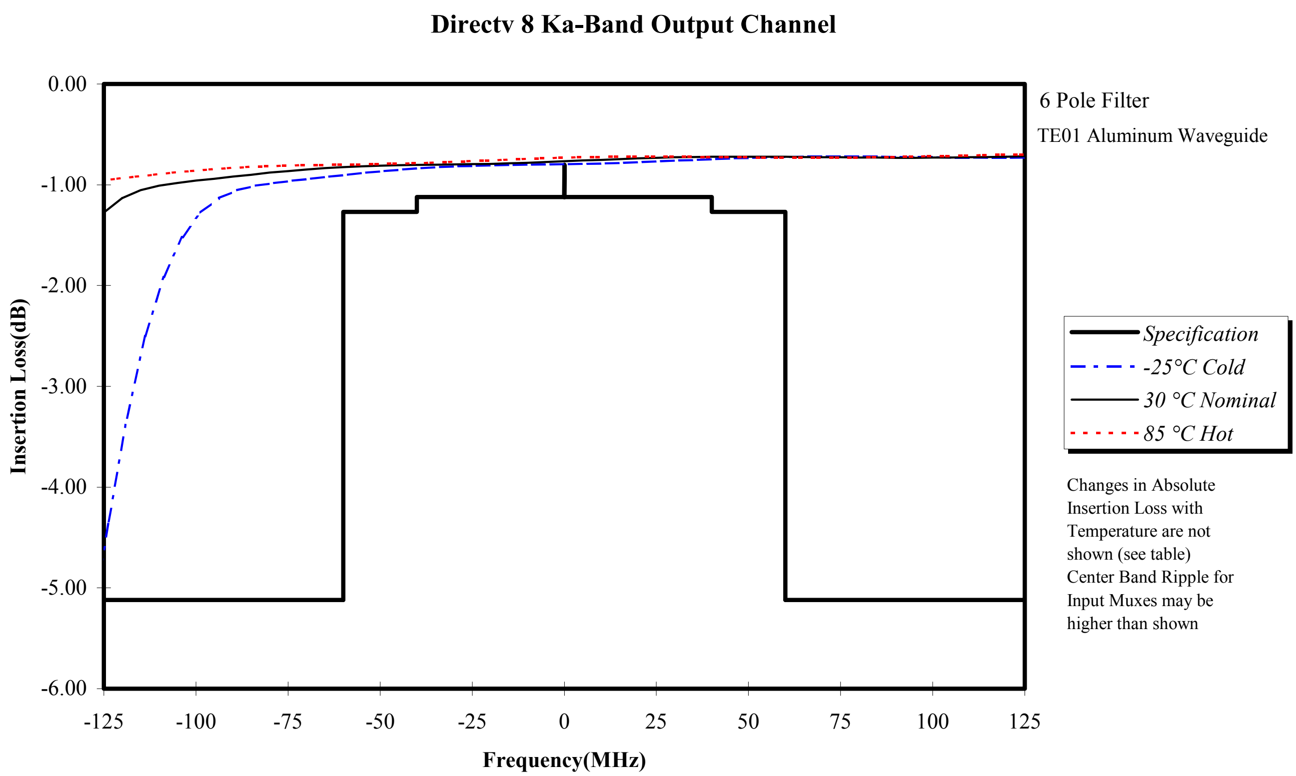

Figure 5-8. 18.3-18.8 GHz Lower 250 MHz Channel Output Filter Predicted Insertion Loss

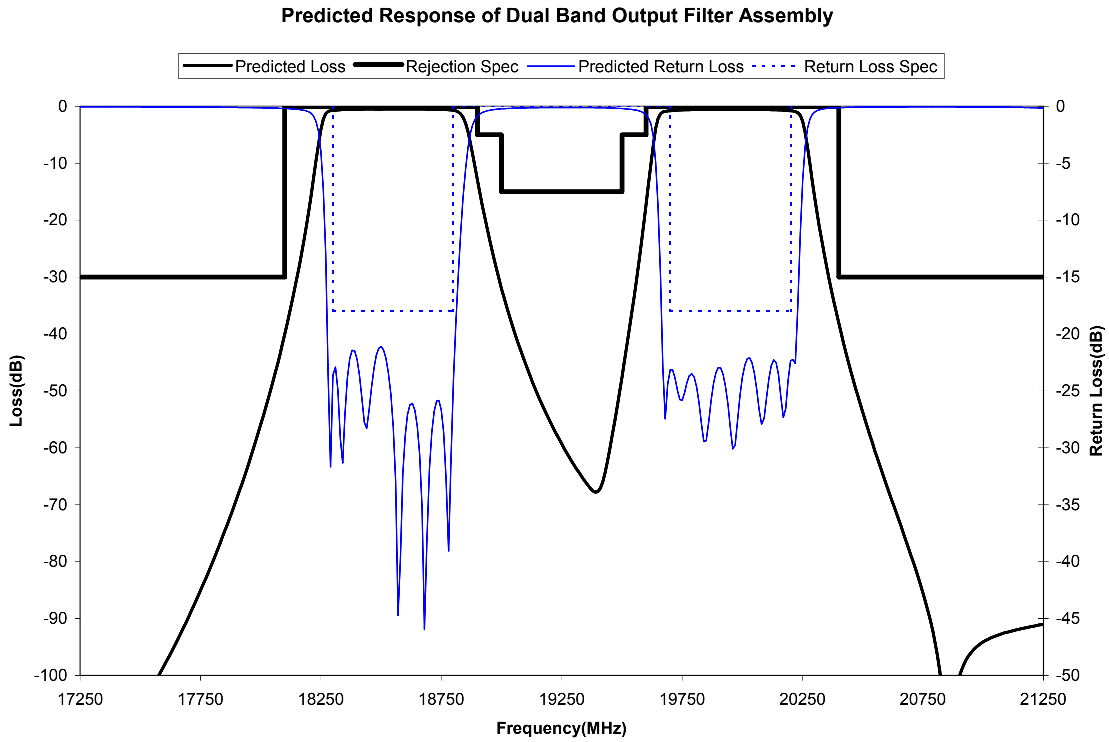

Figure 5-9. Combined Ka-Band Output Filter Response

5.3 TT&C Subsystem

The TT&C subsystem provides redundant telemetry, tracking, and control channels for the spacecraft. The principal functions of the subsystem are:

1. Reception and amplification of the Radio Frequency (RF) command uplinks and demodulation of baseband for subsequent signal processing and command distribution
2. Modulation, up-conversion, amplification, and transmission of all telemetry data
3. Reception and retransmission of ground-station-generated ranging signals

Figure 5-10 shows a simplified block diagram of the TT&C subsystem. The subsystem is configurable to accommodate the unique requirements of pre-launch, orbit raising, and on-station synchronous orbit operations. Access at initial spacecraft acquisition and major orbit-raising maneuvers is via the wide-beam (+Z) and narrow-beam (-Z) omni antennas. During the orbit-raising mission phase, the command uplink uses the 14 GHz omni antenna. The telemetry signals are routed through the 12 GHz omni antennas using the 35W TWTAs.

Once on station, the command and telemetry systems are reconfigured to use the communications payload antennas. The command signal goes through the Ku-band receive antenna and the telemetry signal is routed through the Ku-band transmit antenna by the appropriate setting of an R-switch.

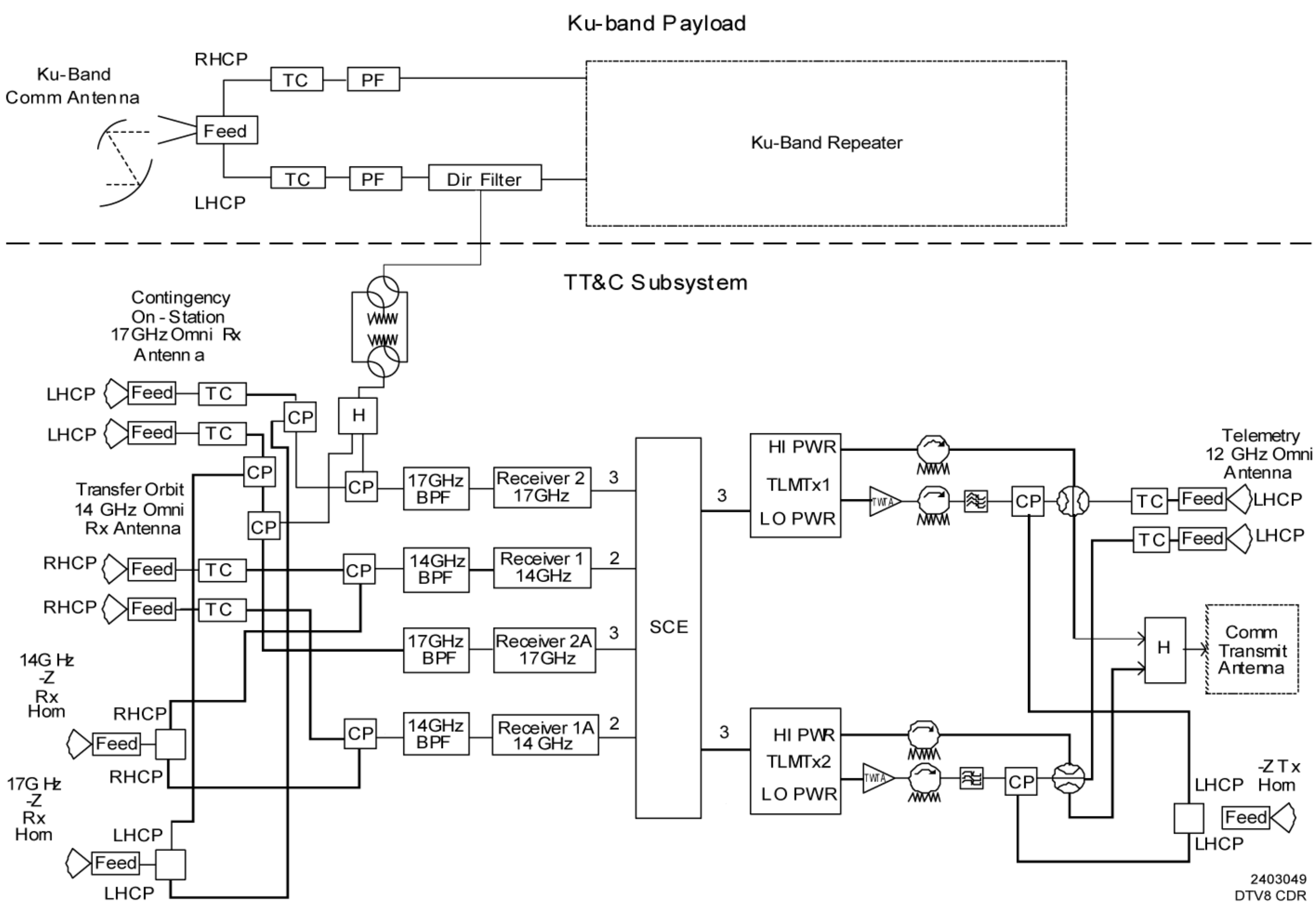

Figure 5-10. TT&C Simplified Block Diagram

The telemetry and command link performance for on-station operation is summarized in the link budget analysis in Appendix C. The antenna patterns for the TT&C subsystem are discussed in Section 7.3. The emission designators associated with the TT&C subsystem are 2M00F9D for command, 2M00F8D for ranging, and 2M00G9D for telemetry, and the associated allocated bandwidth is 2 MHz for each of these emissions.

6. Orbital Locations

The DIRECTV 8 satellite has been designed to operate at the nominal 101° W.L. orbital location, which has been previously assigned to DIRECTV for Ka-band[16] and DBS satellite operations. As contemplated under Section 25.210(j)(3) of the Commission's rules, DIRECTV requests that it be authorized to operate at a slight offset from this nominal location, at 100.85° W.L. This offset is necessary due to the presence of six spacecraft – four operated by DIRECTV and two operated by other licensees – at this orbital location. The 0.15° offset from the nominal 101° W.L. orbital location requested by DIRECTV will enhance the safety of all spacecraft operating at this slot.

Moreover, as demonstrated in Section 10, DIRECTV 8 will operate such that it will be able to comply with all coordination thresholds established for blanket licensing of Ka-band earth station terminals even with respect to the satellite licensed to operate at the 99° W.L. orbital location – which is licensed to DIRECTV's corporate parent, The DIRECTV Group, Inc. – even though the satellites would be separated by only 1.8 degrees. Specifically, decreasing orbital separation from 2.0 degrees to 1.8 degrees would increase interference by only 1.15 dB – far less than the 16 dB margin below the coordination threshold at which DIRECTV 8 will operate. Clearly, any satellite located in a slot further east than 99° W.L. would be even less affected, and any slot to the west

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16 At the time the Commission assigned Ka-band orbital locations in the first processing round, the applicants for orbital locations between 95° W.L. and 105° W.L. agreed to operate their satellites with a nominal 0.05° offset to the west in order to increase separation from a Luxembourg satellite filing at 93.2° W.L. *See Assignment of Orbital Locations to Space Stations in the Ka-Band*, 13 FCC Rcd. 1030, Appendix A (Int'l Bur. 1997).

of 101° W.L. would actually experience a marginally improved interference environment. Accordingly, this slight offset will not have any harmful effect on any other licensed Ka-band satellite operator.

7. Predicted Spacecraft Antenna Gain Contours

The 2.0-m Earth deck SOR (Single Offset Reflector) antenna supports the Ka-band back-haul capability with a feed array of six potter horns -- two downlink (20 GHz) feeds and four uplink (30 GHz) feeds. The antenna layout on the spacecraft is shown in Figure 7-1.

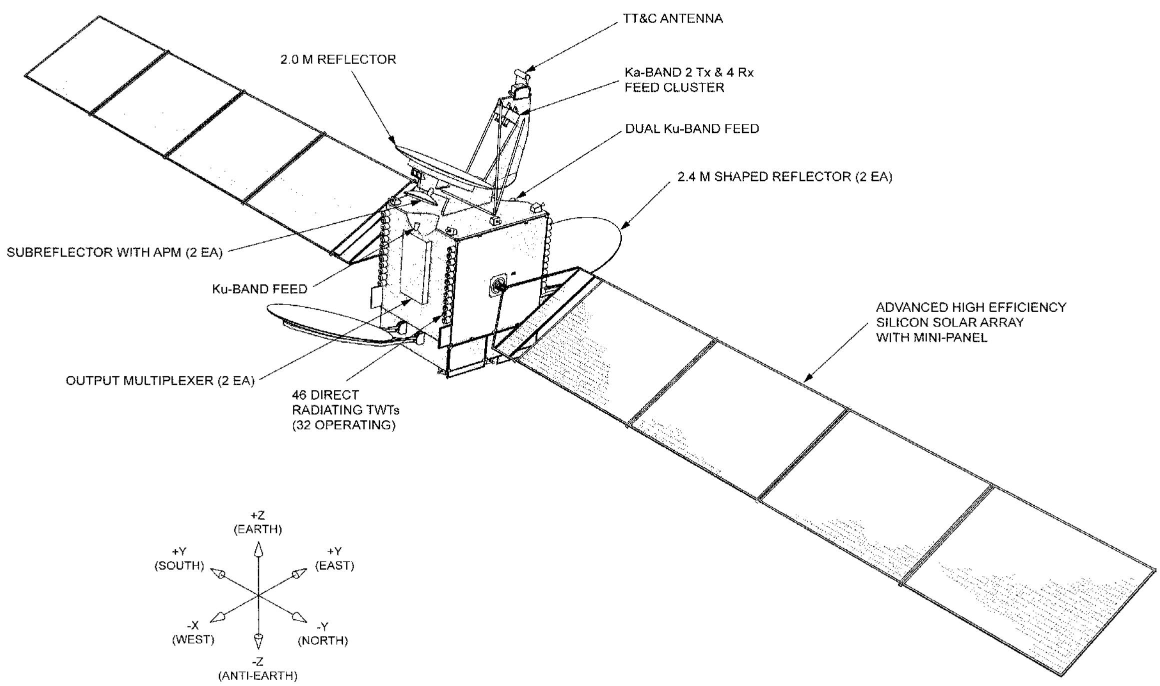

Figure 7-1. Antenna Layout on DIRECTV 8 Spacecraft

7.1 Uplink and Downlink Traffic Beams

The antenna frequency and polarization plan for uplink and downlink traffic beams are set forth in Table 7-1. The antenna coverage characteristics are shown in Table 7-2.

Table 7-1. Frequency and Polarization Plan

Beam		Polarization	Lower Band Edge	Upper Band Edge
			Frequency (MHz)	Bandwidth (MHz)
---			---	---
A1	Uplink	LHCP	29,500	29,750
A2	Uplink	LHCP	29,750	30,000
B1	Uplink	RHCP	29,500	29,750
B2	Uplink	RHCP	29,750	30,000
---			---	---
C1	Uplink	RHCP	28,350	28,600
C2	Uplink	RHCP	29,250	29,500
D1	Uplink	LHCP	28,350	28,600
D2	Uplink	LHCP	29,350	29,500
---			---	---
E1	Downlink	LHCP	18,300	18,800
E2	Downlink	LHCP	19,700	20,200
F1	Downlink	RHCP	18,300	18,800
F2	Downlink	RHCP	19,700	20,200

Table 7-2. Ka-Band Spot Beam Coverage

Spot Beam	Spot Beam Coverage Area	Longitude (Decimal degrees West)	Latitude (Decimal degrees North)	Circular Beam Diameter at Edge of Coverage; Pointing Error Excluded (Degrees in projected 2D satellite coordinates)
B1, B2	Seattle	122.7	47.0	0.15°
A1, A2	Castle Rock	104.81	39.28	0.05°
C1, C2	Atlanta	84.3	33.7	0.15°
D1, D2	New York	73.9	40.9	0.15°
E1,E2	Kansas City	94.6	39.1	0.15°
F1,F2	Los Angeles	118.42	33.98	0.05°

Uplink and downlink spot beam coverage is depicted in Figure 7-2. Coverage area includes any variation in satellite pointing, while in different operating modes. The DIRECTV 8 satellite meets a time weighted 3-sigma pointing error of less than ± 0.14 degrees for nominal day-to-day operations. For all modes, including station-keeping and transition, the 3-sigma pointing error will not exceed 0.21 degrees.

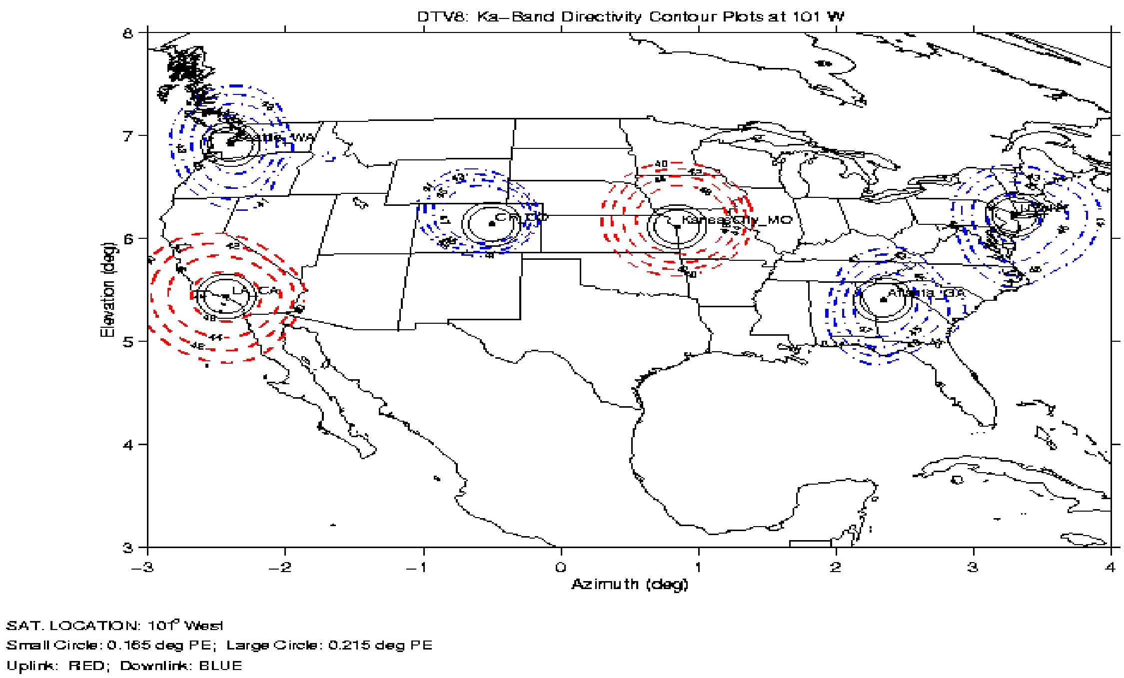

Figure 7-2 Ka-Band Uplink/Downlink Coverage Contours

7.2 TT&C Beams

The TT&C coverage is provided by simple antennas, which are oriented around the nominal +Z direction and the nominal –Z direction. The +Z coverage TT&C antenna uses a wide-flared horn on an open-ended waveguide to provide the wide-angle radiation patterns. Separate radiators are used for the 12-, 14-, and 17-GHz frequencies to satisfy the redundancy requirements. A Meanderline polarizer is placed in front of the waveguide radiators to convert the linearly polarized signals into circular polarization. The –Z coverage is provided by open-ended waveguide horns excited by TNC coax inputs. The horns use septum polarizers to produce circular polarization. The –Z coverage is provided by two telemetry horns at 12 GHz and four command horns at 14

GHz and 17 GHz. The wide beam TT&C antenna RF performance is summarized in Table 7-3 and the antenna coverage is shown in Appendix B as Figure B-3.

Table 7-3. Wide Beam TT&C Antenna Performance Summary

Antenna	Qty	Frequency (GHz)	Polarization	Minimum Antenna Gain (dBi)	Required Coverage (deg)
+Z Wide-angle Ant.	1.0	14.0030	RHCP	-4.0	Az ±110 and El ±50
+Z Wide-angle Ant.	1.0	14.4970	RHCP	-4.0	Az ±110 and El ±50
–Z Wide-angle Ant.	1.0	14.0030	RHCP	2.0	Az ±50 and El ±50
–Z Wide-angle Ant.	1.0	14.4970	RHCP	2.0	Az ±50 and El ±50
–Z Wide-angle Ant.	1.0	17.3070	LHCP	-2.0	Az ±45 and El ±45
–Z Wide-angle Ant.	1.0	17.3070	LHCP	-2.0	Az ±45 and El ±45
+Z Wide-angle Ant.	1.0	17.3070	LHCP	-4.0	Az ±110 and El ± 45
+Z Wide-angle Ant.	1.0	17.3070	LHCP	-4.0	Az ±110 and El ± 45
Telemetry					
+Z Wide-angle Ant.	1.0	12.20325	LHCP	-4.0	Az ±110 and El ±50
+Z Wide-angle Ant.	1.0	12.20375	LHCP	-4.0	Az ±110 and El ±50
–Z Wide-angle Ant.	1.0	12.20325	LHCP	2.0	Az ±50 and El ±50
–Z Wide-angle Ant.	1.0	12.20375	LHCP	2.0	Az ±50 and El ±50

Once the satellite is on station, the telemetry and command signals are routed through the communications subsystem for reception and transmission via the communications antennas. The uplink antenna pattern for this operation is shown in Appendix B as Figure B-1, and the downlink antenna beam pattern is shown in Appendix B as Figure B-2.

8. Service Description, Link Description and Performance Analysis, Earth Station Parameters

8.1 Service Description

DIRECTV currently retransmits the signals of local broadcast stations into over 100 local markets, and the number is expected to increase to approximately 130 markets by the end of this year. As DIRECTV continues to extend such local-into-local service to still more markets, one of the logistical and cost components it faces is arranging to backhaul the broadcast signals from the local markets to a DIRECTV broadcast center. The Ka-band payload on the DIRECTV 8 satellite will provide additional capacity for backhauling these signals, using its own facilities rather than paying for the use of terrestrial fiber optic lines or satellite capacity on another operator's FSS system. Local signals from a number of markets could be transported a relatively short distance to one of four aggregation points (Northwest, Central, Southeast, and Northeast), from which they could be uplinked to DIRECTV 8 and downlinked to DIRECTV's Los Angeles broadcast operations center. Such a backhaul option will improve the cost effectiveness of providing local-into-local service in additional markets, and thus will better enable DIRECTV to provide even more American consumers with their local broadcast channels. The satellite will also provide a redundant link for communications from the broadcast center in Castle Rock to the one in Los Angeles.

8.2 Link Performance

Tables A-1 to A-3 of Appendix A illustrate representative link budgets for the three backhaul carrier types. The pertinent assumptions used are also shown, including an assumed link availability of 99.99%. These budgets demonstrate compliance with, and relative margin to, the off-axis EIRP coordination thresholds in Section 25.138 of the Commission's rules. The downlink EIRP compliance with this same section is discussed in Section 10, below. Appendix A demonstrates that using the requested system modifications, DIRECTV will remain in compliance with the relevant FCC technical rules.

Tables B-1 and B-2 illustrate the link budgets for the on station telemetry and command links, respectively.

8.3 Earth Station Parameters

The DIRECTV 8 Ka-band satellite will support DIRECTV backhaul operations from/to a limited number of earth stations. The earth stations used for this operation will be relatively large antennas (on the order of nine meters) situated at strategically located video programming collection points. DIRECTV will submit individual earth station applications for each of these stations in the future.

9. Satellite Orbit Characteristics

The DIRECTV 8 satellite will be maintained in synchronous orbit at its nominal orbital location with a North-to-South drift tolerance of $\pm 0.05^{o}$ and with an East-to-West drift tolerance of $\pm 0.05^{o}$. The antenna axis attitude will be maintained within ± 0.119° during normal mode and ± 0.199° during orbit maneuvers (*i.e.,* stationkeeping). The time weighted pointing error for the Ka-band antennas is less than ± 0.14.

10. Power Flux Density Compliance

In the 19.7-20.2 GHz band, DIRECTV 8 will comply with the Ka-band blanket licensing coordination threshold of –118 $dBW/m^2/MHz$. In all cases the upper bound on maximum power flux density ("PFD") on the surface of the earth is determined by operating the system with a maximum per carrier EIRP of 41.8 dBW. With this level of EIRP per carrier, the Commission's blanket licensing coordination threshold will be met for any uniform spectral density carrier with a bandwidth greater than 316.2 kHz. The communications carriers to be transmitted by DIRECTV 8 will have bandwidths of 24 MHz, 36 MHz and 54 MHz. With these bandwidths, and the stated per-carrier transmit power, the maximum PFD on the surface of the Earth is -134.4 $dBW/m^2/MHz$ (*i.e.*, 41.8 (dBW) – 10log(24) (dB-MHz) – 162.4 ($dB\text{-}m^2$)) – or over 16 dB below the coordination threshold. With this maximum PFD, DIRECTV 8 will cause far less interference to any neighboring satellite, even with the minor orbital offset requested in Section 6, than would be caused by a spacecraft operated at the -118 dBW/m^2/MHz PFD coordination threshold from a slot located two degrees from its neighbors. Specifically, reducing the orbital separation from 2.0 degrees to 1.8 degrees would increase interference by 1.15 dB – far less than the 16 dB margin below the coordination threshold at which DIRECTV 8 will operate.[17]

The downlink operating in the 18.3-18.8 GHz band will also comply with the downlink PFD limits established in Section 25.208 of the Commission's rules, which are as follows:

- -115 dB (W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
- -115 + 0.5 (d-5) dB (W/m^2) in any 1 MHz band for angles of arrival d (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -105 dB (W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

In this frequency band, with the same 41.8 dBW maximum EIRP per carrier limitation still applied, this PFD limit will be met for any carrier to be transmitted by DIRECTV 8, as is demonstrated above.[18] In addition, the discussion above also demonstrates that the PFD across the 200 MHz band 18.6-18.8 GHz will not exceed –95 dB (W/m^2) for any angle of arrival.

11. Arrangement for Tracking, Telemetry and Control

DIRECTV 8's TT&C operations will be performed by Space Systems Loral, Long Term Operations. The control center is located in El Dorado Hills, CA. The

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17 It is also worth bearing in mind that the orbital location most directly affected by the proposed offset – 99° W.L. – is licensed to DIRECTV's parent company, The DIRECTV Group, Inc.

18 It should be noted that the maximum PFD value is also below the value given in § 25.138(a)(6) for blanket licensing of small user terminals.

primary TT&C uplink will come from DIRECTV's Castle Rock Broadcast Center, in Castle Rock, CO. The backup TT&C uplink will come from DIRECTV's Los Angeles Broadcast Center, in Los Angeles. CA.

12. Physical Characteristics of the Space Station

Table 12-1 summarizes the key spacecraft characteristics.

Table 12-1. Summary of DIRECTV 8 Characteristics

DIRECTV 8	
Spacecraft:	Loral 1300, three axis stabilized
Launch:	
Vehicle	Proton
Site	Baikonur, Kazakhstan
Orbital slot:	100.85 degrees West longitude
Contract life:	12 years

PAYLOAD	
Hybrid Ku/Ka-band	12.2-12.7 GHz, 18.3-18.8 GHz and 19.7-20.2 GHz (space-to-Earth), 17.3-17.8 GHz, 28.35-28.6 GHz, 29.25-30.0 GHz (Earth-to-space)

POWER	
Solar Array:	Two solar wings. Each wing with four panels
Payload Load	5763W (worst case EOL @ equinox)
Bus Load	1874W (worst case EOL @ equinox)
Total Load	7637W including battery charge power(worst case EOL @ equinox)
Array Power Available	8399W (worst case EOL @ equinox)
Batteries: **Depth of Discharge (%)**	71.8%

DIMENSIONS	
In-orbit	31.3 m long, solar arrays: 8.7 m wide, antennas/radiators: 6.2 m tall, antenna
Stowed	H: 6.2 m W: 3.2 m
Mass	
At Launch	3707.9Kg
In-orbit (beginning of life)	2060.4Kg
End of life	1501.9Kg

ANTENNAS
Receive – 2.4 meter deployable, shaped main reflector and subreflector on East **Transmit** – 2.4 meter deployable, shaped main reflector and subreflector on East and West

13. Spacecraft Bus Subsystem

The spacecraft, part of Loral's 1300 bus series, encompasses the following design elements.

1. A rectangular mainbody that houses internal electronic equipment and externally supports communication antennas on the earth-facing side (Ka-band receive/transmit antenna), east side (Ku-band receive and transmit antenna), and west side (Ku-band transmit antenna) of the spacecraft.
2. A four-panel and a yoke mini panel-per-wing deployable solar array. The four panels are populated with Advanced High Efficiency Silicon (AHES) solar cells. The mini-panel is populated with High Efficiency Silicon (HES) solar cells. For eclipse operation, power is stored in two 34-cell, 149-Ah nickel-hydrogen (NiH_2) batteries.
3. Stabilization on orbit and antenna pointing are accomplished using a momentum-biased Attitude Determination and Control System (ADCS). This system measures satellite attitude, relative to the Earth, via scanning infrared Earth sensors; processes the error information; and controls the spacecraft by operation of the momentum wheels. For normal operation, two momentum wheels operate in a 'V' mode. In the unlikely event of a momentum wheel failure, a reaction wheel provides redundancy and operation in the 'L' mode. These elements provide for the required pointing stability.
4. The design of the bi-propellant propulsion subsystem has a strong, successful heritage history. Propellants for the integrated bipropellant propulsion system are stored in two large cylindrical tanks that are supported within the spacecraft central cylinder. Pressure to the system is provided by two cylindrical helium-filled pressurant tanks located on the east and west sides of the mainbody just above the ADCS deck. The 12 attitude control thrusters are mounted on the corners and north and south sides of the mainbody on the Earth and anti-Earth decks. The main satellite thruster is located in the lower central cylinder along the mainbody thrust-axis, pointing in the anti-Earth direction. The bipropellant reaction control system incorporates integral latch valves and thruster valves for maximum reliability.

5. The Orbital Maneuver Lifetime (OML) of 12 years is achieved on Proton M/Breeze M, Sea Launch, Ariane V, Atlas V, and H-IIA launch vehicles. DIRECTV has procured a slot on International Launch Services' manifest for a Proton M launch in the second quarter of 2005.

Figure 13-1 shows the on-orbit configuration.

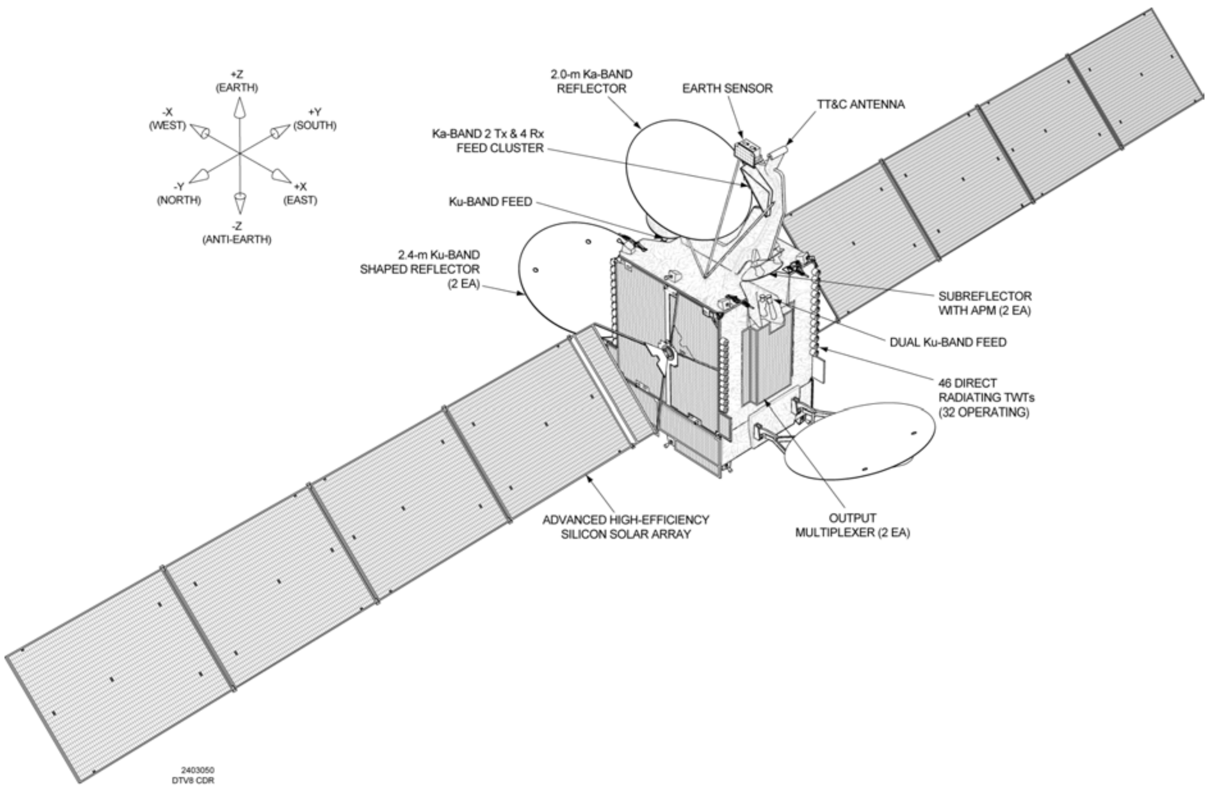

Figure 13-1. On-Orbit Configuration of DIRECTV 8

14. Common Carrier Status

DIRECTV intends to operate DIRECTV 8 on a non-broadcast, non-common carrier basis, as it operates its current satellite capacity at 101° W.L., 110° W.L., and 119° W.L. DIRECTV may sell and/or lease a portion of its capacity on a non-common carrier basis for complementary business purposes.

15. Schedule

DIRECTV anticipates that it will complete construction and launch the satellite in the spring of 2005, and place it into service before its June 25, 2005 operational milestone.

16. Public Interest Considerations

See Section II above.

17. Interference Analysis Demonstrating Two-Degree Spacing Compatibility

Tables A-1 to A-3 of Appendix A demonstrate that the modified satellite design described in this application is compatible with the Commission's two-degree spacing policy and implementing rules, and also show the anticipated margin relative to the off-axis EIRP coordination threshold. Accordingly, using the requested system modifications, the proposed Ka-band satellite will remain in compliance with the relevant Commission technical rules.

Since the Commission licensed DIRECTV's Ka-band system in 1997, a number of important developments have been instituted to establish compatibility between new satellite systems. At Ka-band, in order to achieve maximum compatibility between diverse networks, the Commission has established coordination thresholds for earth station EIRP off-axis thresholds and spacecraft PFD in the *18 GHz Order*.[19] These operational restrictions are the outcome of the blanket licensing parameters coordinated by industry for Ka-band earth terminals. This modification proposal is fully compatible with this aspect of the *18 GHz Order*. For U.S. service from 101° W.L., the system complies with the established –118 dBW/m^2/MHz PFD threshold and the uplink earth

[19] *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Station in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite Service Use*, 15 FCC Rcd. 13430 (2000)("*18 GHz Order*").

terminal EIRP off-axis threshold, as well as the PFD limitations established in Section 25.208 of the Commission's rules. This compliance is demonstrated in Appendix A.

The interference studies that are included in this request for modification are performed in conjunction with the end-to-end link performance analyses. Abbreviated link budgets for all uplink and downlink operating modes are presented in Tables A-1 through A-3 in Appendix A. The uplink data rate modes of 60 Mbps and 90 Mbps are considered in Tables A-1 to A-3. In each case, the analysis includes the effects of adjacent satellite interference in evaluating whether the system accommodates the various data rates at acceptable C / (N+I) thresholds.

To properly account for all interference from the adjacent operating satellite systems, the uplink budgets include aggregate interference from earth terminals associated with pairs of satellites at 2, 4, 6 and 8 degrees of orbit separation. The budgets use a level of assumed interference that accounts for the maximum level permissible under the off-axis coordination threshold directive. On the downlink, the adjacent pairs of satellites also at 2, 4, 6 and 8 degrees of orbit separation are each assumed to produce an interference equivalent to that of the PFD coordination threshold value of –118 $dBW/m^2/MHz$. In all cases it is shown that the modified system, as proposed, will be able to successfully operate in this assumed interference environment.

18. Orbital Debris Mitigation

On June 21, 2004, the Commission adopted an order establishing new orbital debris mitigation requirements for satellite applications.[20] Those rules have not yet gone into effect,[21] and DIRECTV is not now in a position to provide all of the information required under the new regime. However, DIRECTV can state as follows.

To control orbital debris, DIRECTV will use a design for its satellite and launch vehicle that minimizes the amount of debris released during normal operations. To ensure that its satellite does not become a source of orbital debris, DIRECTV will conduct an analysis to ensure that the probability of collision with any known space-borne objects during its normal operation lifetime is minimal. DIRECTV will also conduct an analysis that demonstrates that no realistic failure modes exist or can lead to an accidental explosion during normal operations or before completion of post-operations disposal. At the end of the operational life of the satellite, DIRECTV will maneuver its spacecraft to a storage orbit with a perigee altitude above its normal operational orbit. DIRECTV will use a maneuver strategy that reduces the risk of leaving any of its spacecraft near an operational orbit. After the spacecraft reaches its final disposal orbit, all on-board sources of stored energy will be depleted or safely secured.

DIRECTV will supplement this information as necessary to comply with the Commission's new orbital debris disclosure rules as required once they become effective.

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20 *See Mitigation of Orbital Debris*, FCC 04-130 (rel. June 21, 2004).

21 *See* 47 C.F.R. § 1.427 (rules may be made effective no earlier than 30 days after publication in the Federal Register, absent an explicit finding of good cause for earlier effective date).

VI. Conclusion

In summary, the proposed modifications will provide DIRECTV with increased FSS capabilities in support of its provision of local-into-local services throughout the United States. The current system design together with the proposed modifications is fully compliant with the Commission's rules relating to Ka-band earth station blanket licensing. The modifications fully comport with long-established Commission precedent that allows licensees to modify the design of their licensed systems during the construction phase to take into account changes in technology and to otherwise optimize their systems. These new design features will create a platform capable of complementing DIRECTV's other satellite operations so that it can more efficiently and effectively meet the needs of American consumers.

For these reasons, DIRECTV submits that the proposed minor modification request is in the public interest and respectfully requests that the Commission expeditiously grant this request.

Respectfully submitted,

DIRECTV ENTERPRISES, LLC

By: \s\
Romulo Pontual
Executive Vice President

ENGINEERING CERTIFICATION

The undersigned hereby certifies to the Federal Communications Commission as follows:

(i) He is the technically qualified person responsible for the engineering information contained in the foregoing Application for Minor Modification,

(ii) He is familiar with Part 25 of the Commission's Rules, and

(iii) He has either prepared or reviewed the engineering information contained in the foregoing Application for Minor Modification, and it is complete and accurate to the best of his knowledge and belief.

Signed:

/s/
Jack Wengryniuk

June 30, 2004
Date

APPENDIX A

Link Budgets and Interference Analysis

Figure A-1. DIRECTV 8 Ka-Band Link Budget and Off-Axis EIRP Compliance for 24 MHz Backhaul Carrier

DIRECTV 8 Ka Band, 101W		**Clear Sky**	**Rain Dn**	**Notes**
Uplink C/N (thermal), dB	Transmit power, dBW	13.7	18.7	
Castle Rock	Transmit losses, dB	-2.0	-2.0	
	Ground antenna gain, dB	66.8	66.8	9 meter
	Antenna pointing loss, dB	-0.5	-0.5	
	Free space loss, dB	-213.3	-213.3	
	Atmospheric loss, dB	-1.1	-1.1	
	Uplink rain loss, dB	0.0	-5.0	
	Satellite G/T, dB/K	8.9	8.9	
	Bandwidth, dB-Hz	-73.0	-73.0	20 Msps
	Boltzmann's constant, dBW/Hz K	228.6	228.6	
Total Uplink C/N		**28.1**	**28.1**	
Downlink C/N (thermal),dB	Satellite EIRP, dBW/24 MHz	41.8	41.8	Max EIRP per carrier
Los Angeles	Free space loss, dB	-209.9	-209.9	
	Atmospheric loss, dB	-1.0	-1.0	
	Downlink rain loss, dB	0.0	-9.3	99.99% Avail.
	Rain temp increase, dB	0.0	-3.7	
	Rcv. antenna pointing loss, dB	-0.5	-0.5	
	Ground G/T, dB/K	41.0	41.0	9 meter
	Bandwidth, dB-Hz	-73.0	-73.0	
	Boltzmann's constant, dBW/Hz K	228.6	228.6	
Total Downlink C/N		**27.0**	**13.9**	
		Clear Sky	**Rain Dn**	
Totals	Uplink C/N (thermal), dB	28.1	28.1	
	Downlink C/N (thermal), dB	27.0	13.9	
	x-pol interference, dB	22.9	22.9	
	Aggregate C/I from ASI*	29.3	29.3	
	Aggregate C/I from TX E/S (U/L)	35.7	35.7	
	Total C/(N+I), dB	**19.9**	**13.1**	
	Required C/(N+I), dB	**9.0**	**9.0**	8PSK 3/4
	Margin, dB	**10.9**	**4.1**	

* Based on -118 dBW/m^2/MHz from satellites at +/- 2, 4, 6 and 8 deg. Off-axis = 29-25log(theta) + 8 dB

Figure A-1 (cont). DIRECTV 8 Ka-Band Link Budget and Off-Axis EIRP Compliance for 24 MHz Backhaul Carrier

DIRECTV 8 Feeder-link Off-axis EIRP Compliance				
Max Clear Sky TX power (minus losses) = 11.7 dBW/24 MHz = -16.1 dBW/40 kHz				
Feeder-link antenna conforms to §25.209				
Degrees off-axis	**§25.209 Allowable Antenna Gain, dB**	**Max DIRECTV 8 FL EIRP, dBW/40 kHz**	**§25.138 Allowable Off-Axis EIRP, dBW/40 kHz**	**Margin, dB**
2.0	21.5	5.4	11.0	5.6
4.0	13.9	-2.2	3.4	5.6
6.0	9.5	-6.6	-1.0	5.6
8.0	6.4	-9.7	-2.6	7.1

Figure A-2. DIRECTV 8 Ka-Band Link Budget and Off-Axis EIRP Compliance for 36 MHz Backhaul Carrier

DIRECTV 8 Ka Band, 101W		**Clear Sky**	**Rain Dn**	**Notes**
Uplink C/N (thermal), dB	Transmit power, dBW	13.7	18.7	
Castle Rock	Transmit losses, dB	-2.0	-2.0	
	Ground antenna gain, dB	66.8	66.8	9 meter
	Antenna pointing loss, dB	-0.5	-0.5	
	Free space loss, dB	-213.3	-213.3	
	Atmospheric loss, dB	-1.1	-1.1	
	Uplink rain loss, dB	0.0	-5.0	
	Satellite G/T, dB/K	8.9	8.9	
	Bandwidth, dB-Hz	-75.5	-75.5	30 Msps
	Boltzmann's constant, dBW/Hz K	228.6	228.6	
Total Uplink C/N		**25.6**	**25.6**	
Downlink C/N (thermal),dB	Satellite EIRP, dBW/36 MHz	41.8	41.8	Max EIRP per carrier
Los Angeles	Free space loss, dB	-209.9	-209.9	
	Atmospheric loss, dB	-1.0	-1.0	
	Downlink rain loss, dB	0.0	-9.3	99.99% Avail.
	Rain temp increase, dB	0.0	-3.7	
	Rcv. antenna pointing loss, dB	-0.5	-0.5	
	Ground G/T, dB/K	41.0	41.0	9 meter
	Bandwidth, dB-Hz	-75.5	-75.5	
	Boltzmann's constant, dBW/Hz K	228.6	228.6	
Total Downlink C/N		**24.5**	**11.4**	
		Clear Sky	**Rain Dn**	
Totals	Uplink C/N (thermal), dB	25.6	25.6	
	Downlink C/N (thermal), dB	24.5	11.4	
	x-pol interference, dB	22.9	22.9	
	Aggregate C/I from ASI	27.5	27.5	
	Aggregate C/I from TX E/S (U/L)	33.9	33.9	
	Total C/(N+I), dB	**18.6**	**10.9**	
	Required C/(N+I), dB	**9.0**	**9.0**	8PSK 3/4
	Margin, dB	**9.6**	**1.9**	

* Based on -118 dBW/m^2/MHz from satellites at +/- 2, 4, 6 and 8 deg. Off-axis = 29-25log(theta) + 8 dB

Figure A-2 (cont.). DIRECTV 8 Ka-Band Link Budget and Off-Axis EIRP Compliance for 36 MHz Backhaul Carrier

DIRECTV 8 Feeder-link Off-axis EIRP Compliance				
Max Clear Sky TX power (minus losses) = 11.7 dBW/24 MHz = -16.1 dBW/40 kHz				
Feeder-link antenna conforms to §25.209				
Degrees off-axis	**§25.209 Allowable Antenna Gain, dB**	**Max DIRECTV 8 FL EIRP, dBW/40 kHz**	**§25.138 Allowable Off-Axis EIRP, dBW/40 kHz**	**Margin, dB**
2.0	21.5	5.4	11.0	5.6
4.0	13.9	-2.2	3.4	5.6
6.0	9.5	-6.6	-1.0	5.6
8.0	6.4	-9.7	-2.6	7.1

Figure A-3. DIRECTV 8 Ka-Band Link Budget and Off-Axis EIRP Compliance for 54 MHz Backhaul Carrier

DIRECTV 8 Ka Band, 101W		**Clear Sky**	**Rain Dn**	**Notes**
Uplink C/N (thermal), dB	Transmit power, dBW	13.7	18.7	
Castle Rock	Transmit losses, dB	-2.0	-2.0	
	Ground antenna gain, dB	66.8	66.8	9 meter
	Antenna pointing loss, dB	-0.5	-0.5	
	Free space loss, dB	-213.3	-213.3	
	Atmospheric loss, dB	-1.1	-1.1	
	Uplink rain loss, dB	0.0	-5.0	
	Satellite G/T, dB/K	8.9	8.9	
	Bandwidth, dB-Hz	-76.5	-76.5	45 Msps
	Boltzmann's constant, dBW/Hz K	228.6	228.6	
Total Uplink C/N		**24.6**	**24.6**	
Downlink C/N (thermal),dB	Satellite EIRP, dBW/54 MHz	41.8	41.8	Max EIRP per carrier
Los Angeles	Free space loss, dB	-209.9	-209.9	
	Atmospheric loss, dB	-1.0	-1.0	
	Downlink rain loss, dB	0.0	-9.3	99.99% Avail.
	Rain temp increase, dB	0.0	-3.7	
	Rcv. antenna pointing loss, dB	-0.5	-0.5	
	Ground G/T, dB/K	41.0	41.0	9 meter
	Bandwidth, dB-Hz	-76.5	-76.5	
	Boltzmann's constant, dBW/Hz K	228.6	228.6	
Total Downlink C/N		**23.5**	**10.4**	
		Clear Sky	**Rain Dn**	
Totals	Uplink C/N (thermal), dB	24.6	24.6	
	Downlink C/N (thermal), dB	23.5	10.4	
	x-pol interference, dB	22.9	22.9	
	Aggregate C/I from ASI	25.8	25.8	
	Aggregate C/I from TX E/S (U/L)	32.1	32.1	
	Total C/(N+I), dB	**17.9**	**9.9**	
	Required C/(N+I), dB	**9.0**	**9.0**	8PSK 3/4
	Margin, dB	**8.9**	**0.9**	

* Based on -118 dBW/m^2/MHz from satellites at +/- 2, 4, 6 and 8 deg. Off-axis = 29-25log(theta) + 8 dB

Figure A-3 (cont.). DIRECTV 8 Ka-Band Link Budget and Off-Axis EIRP Compliance for 54 MHz Backhaul Carrier

DIRECTV 8 Feeder-link Off-axis EIRP Compliance				
Max Clear Sky TX power (minus losses) = 11.7 dBW/24 MHz = -16.1 dBW/40 kHz				
Feeder-link antenna conforms to §25.209				
Degrees off-axis	**§25.209 Allowable Antenna Gain, dB**	**Max DIRECTV 8 FL EIRP, dBW/40 kHz**	**§25.138 Allowable Off-Axis EIRP, dBW/40 kHz**	**Margin, dB**
2.0	21.5	5.4	11.0	5.6
4.0	13.9	-2.2	3.4	5.6
6.0	9.5	-6.6	-1.0	5.6
8.0	6.4	-9.7	-2.6	7.1

APPENDIX B

TT&C Antenna Beams and Link Budgets

Figure B-1. DIRECTV 8 On-Station Command Beam

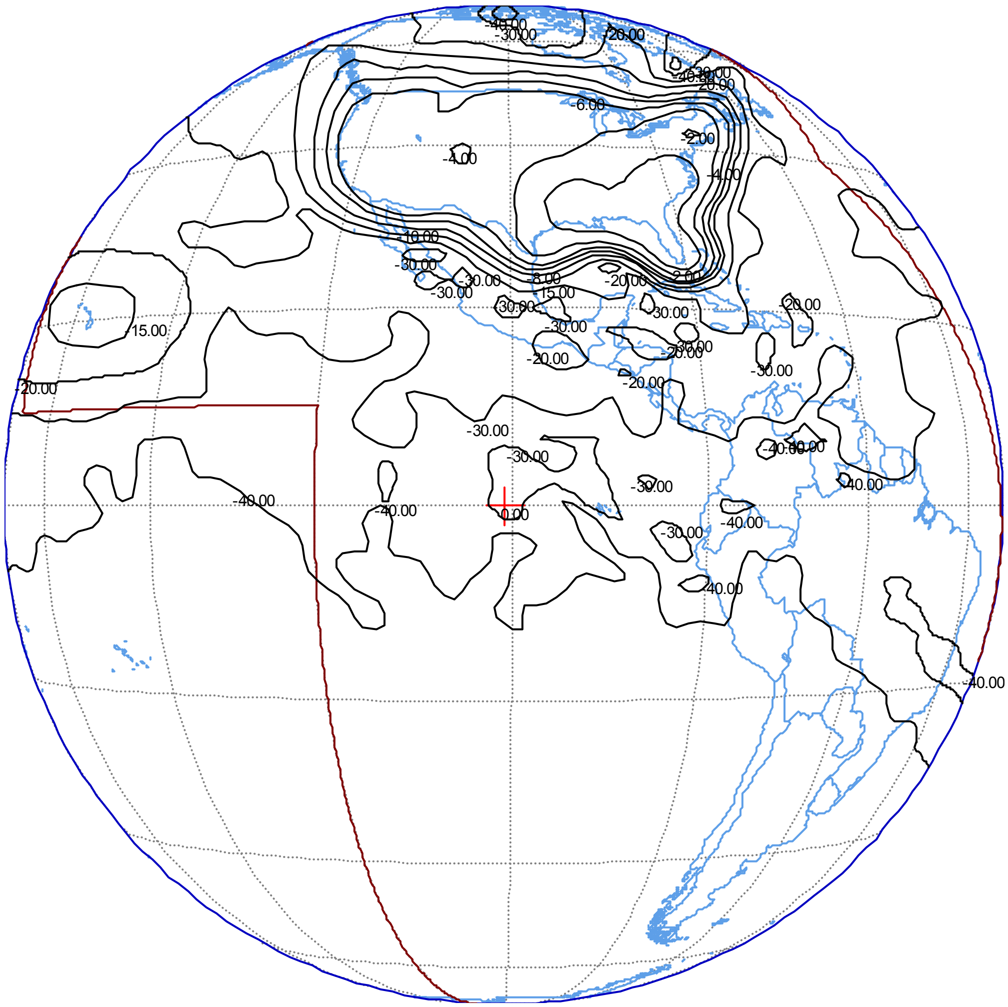

Figure B-2. DIRECTV 8 On-Station Telemetry Beam

Figure B-3. TT&C +Z and –Z Wide Angle Antenna Coverage

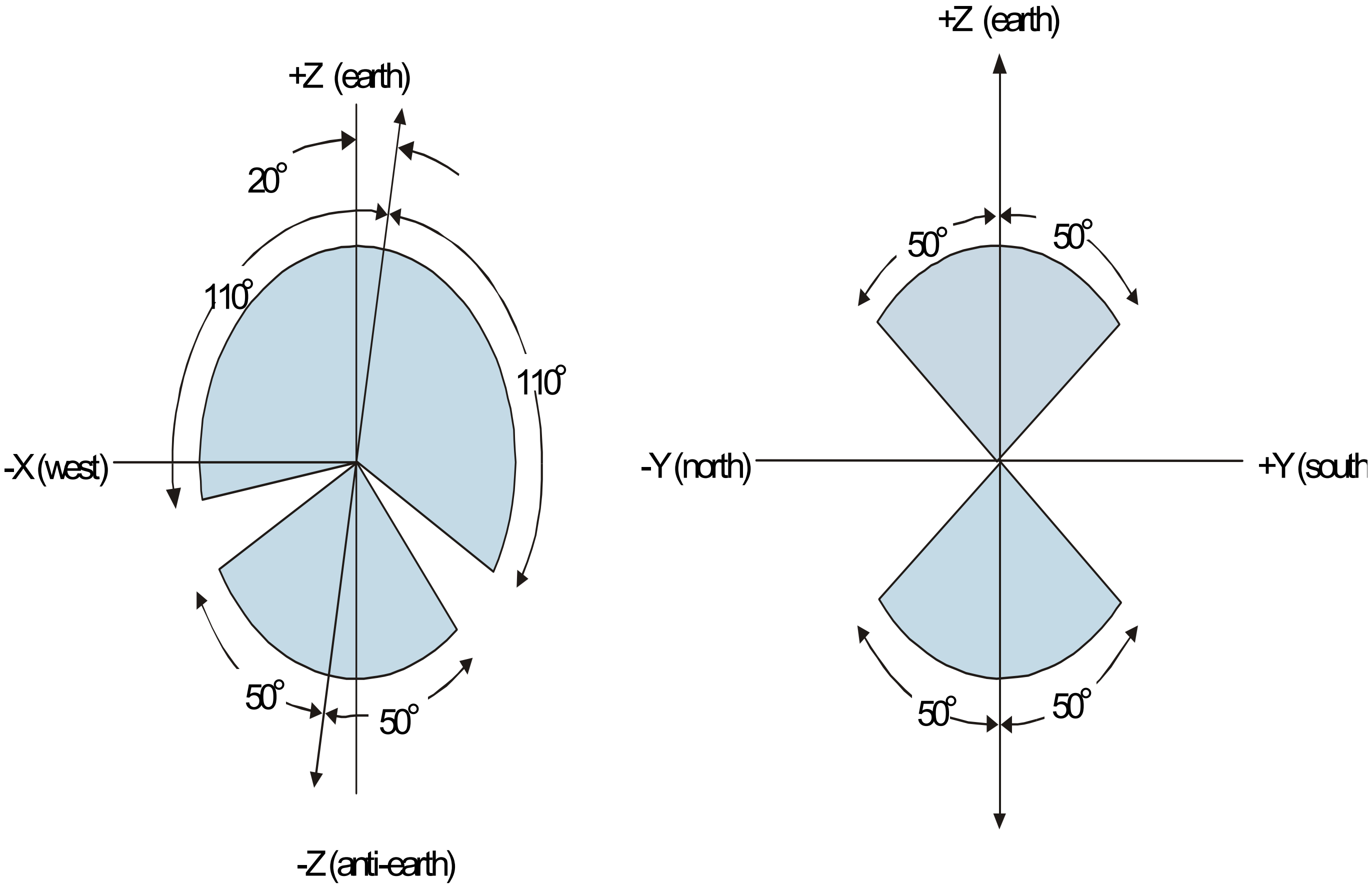

Table B-1. On Station Telemetry Link Budget

DIRECTV 8 On-station Telemetry	**CRK/LA Comm. Antenna**	**Units**
Frequency	12.2	GHz
TWTA output power	-4.0	dBW
Total transmit losses	-7.7	dB
Antenna gain	30.0	dB
EIRP	**18.3**	dBW
Required	**12.0**	dBW
Margin	**6.3**	dB

Table B-2. On Station Command Link Budget

DIRECTV 8 On-station Command, EOC	**Hi U/L**	**Lo U/L**	**Units**
Frequency	17.3	17.3	GHz
Incident flux density	-50.0	-102.0	dBW/m^2
Isotropic area	-46.2	-46.2	dB-m^2
Antenna gain	30.0	30.0	dB
Total receive losses	-16.0	-16.0	dB
Command receiver input power	**-52.2**	**-104.2**	dBm
Command receiver threshold		**-112.0**	dBm
Margin		**7.8**	dB
Command receiver max input power	**-35.0**		dBm
Margin	**17.2**		dB